

DIVISION 6 –
PORTLAND CEMENT CONCRETE PAVEMENTS

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NOTES

Section 601. Reserved

Section 602. Concrete Pavement Construction

602.01. Description

This work consists of constructing a jointed portland cement concrete pavement, unbonded concrete overlay, base course, or shoulder, with or without reinforcement. This work also includes submitting a concrete quality control (QC) plan in accordance with section 1002 before beginning concrete production.

- A. **Definitions.** The term “pavement,” as used in these specifications, may include the following:

Concrete Base Course. Concrete pavement that will be surfaced with hot mix asphalt (HMA) or concrete overlay.

Concrete Overlay. Concrete pavement placed on an existing pavement section. Typical sections consist of standard widths and of lengths that are conducive to production paving.

Concrete Pavement. Concrete placed for mainline pavement, multiple-lane ramps, and collector-distributor roadways. Typical sections consist of standard widths and of lengths that are conducive to production paving.

Concrete Pavement with Integral Curb. Pavement and curb constructed monolithically.

Concrete Shoulders. Concrete pavements placed as shoulders.

Miscellaneous Concrete Pavement and Miscellaneous Concrete

Overlay. Concrete placed for single-lane ramps, acceleration/deceleration lanes, approaches, intersections, and pavement gaps. Typical sections consist of variable widths and of limited lengths that are not conducive to production paving.

Temporary Concrete Pavement. Concrete pavements constructed for temporary duration.

602.02. Materials

Provide materials in accordance with the following sections:

Curing Materials.....	903
Epoxy Coated Lane Ties.....	914
Steel Reinforcement	905
Bond Breaker Material	914
Joint Materials.....	914
Concrete, Grades 3000, 3500, 3500HP	1004

Provide Grade 3500 or Grade 3500HP for concrete pavement, miscellaneous concrete pavement, concrete overlay, and miscellaneous concrete overlay.

Provide Grade 3000, Grade 3500, or Grade 3500HP for concrete base course, concrete shoulders, and temporary concrete pavement.

The Engineer may approve Grade 3500HP for other applications.

Where concrete shoulders are cast monolithically with concrete pavement, provide the grade required for the concrete pavement.

Provide curing compounds in accordance with subsection 903.06 and the following:

- A. Transparent curing compound for base course concrete;
- B. White or transparent curing compound for temporary concrete pavement; and
- C. White curing compound for other pavement, shoulders, and curb surfaces.

602.03. Construction

- A. **Equipment.** Provide and maintain equipment necessary to complete the work.

- 1. **Fixed Forms and Back-Up Rails.** If paving with fixed forms, use back-up rails attached to the forms to raise equipment wheel flanges clear of previously cast pavement.

Use metal forms with section rigidity to support the paving.

Use flexible or standard steel forms with flexible liners where the radius of the curve is less than 150 feet, except where temporary concrete pavement is required.

- 2. **Compactor.** Use mechanical compactors for constructing aggregate base under the concrete pavement.
 - 3. **Concrete Spreader.** Use a Department-approved device to spread and strike off each layer of concrete and to finish the top layer of concrete. Use a spreader with a weight and rigidity to strike off the concrete to the required grade and profile.
 - 4. **Dowel Bar Insert (DBI).** The Engineer may allow the use of a DBI instead of load transfer assemblies. Use a Department-approved mechanical DBI that automatically installs load transfer bars at the required depth and consolidates the surrounding concrete.

5. **Lane-Tie Installer.** Use a Department-approved manual or mechanical method for installing lane-ties.
6. **Reinforcement Bridge.** For reinforcement not placed on chairs or mechanically lifted off the grade, transfer the reinforcement from the hauling equipment to a movable bridge that spans the newly cast pavement. Use a bridge that can carry the reinforcement load without deflecting the form or rutting the track line.
7. **Internal Vibrator.** Use mechanical internal vibrators, set in accordance with the manufacturer's specifications, that provide concrete consolidation for a radius of 1 foot around the vibrator head.

Use a device to monitor the rate of vibration for each concrete vibrator. Verify that all vibrators are operating properly each day, prior to paving and periodically during daily paving operations. Replace any defective vibrators immediately. Connect the vibrators to start automatically with the forward movement of the equipment and stop automatically when the forward movement stops. Space and operate vibrators as recommended by the manufacturer.

8. **Floating and Finishing Equipment.** Shape, screed, and float the concrete to form a dense, homogeneous pavement, requiring only minimum hand finishing.

Use hand floats and straightedges at least 10 feet long that are rigid and free of warping. Use handles with a length that will allow finishing half the width of the newly placed pavement. Use box or channel hand floats with a floating face at least 6 inches wide.

The Engineer may approve the use of a roller screed or other manual or semi-automated finishing equipment for one lane-width, miscellaneous, and bridge approach concrete pavements if the Contractor demonstrates that methods and equipment meet the requirements of subsection 602.03.A.3.

9. **Straightedges for Testing Surface Smoothness.** Provide two 5-foot straightedges and one 10-foot straightedge, rigid and free from warping, for the Engineer's use.
10. **Stencils.** Use a template device for imprinting the pavement. Provide numerals that are 3 to 4 inches high and at least $\frac{1}{4}$ inch deep.
11. **Foot Bridges.** Use at least one moveable bridge for finishing the pavement, installing monument boxes, performing wet checks, and crossing the pavement. Foot bridges spanning slab widths of at least 16 feet must be equipped with wheels, unless they are an integral part

of the paving equipment. Design and construct foot bridges to prevent contact with the concrete.

12. **Membrane Sprayer.** Use mechanical equipment to apply curing compound to exposed pavement surfaces. Use fully atomizing, self-contained spray equipment that is self-supported on wheels or tracks located outside the newly placed pavement. Continuously mix the compound during application. Apply a continuous uniform film of curing compound to exposed concrete surfaces.

The Engineer may approve hand spraying equipment for small and irregular shapes of new concrete pavement. The sprayer must be capable of applying a uniform film of atomized curing compound at the required rate. Inspect curing compound application equipment before starting daily production to verify its ability to apply the curing compound.

13. **Concrete Saws.** Use a concrete saw for the required application and as recommended by the manufacturer.

14. **Joint Sealing Equipment.** For hot-poured rubber-asphalt type joint sealing compound, use an indirect or double-boiler heating kettle that uses oil as the heat transfer medium. Use a thermostatically controlled heat source, built-in automatic agitator, and thermometers to show the temperature of the melted sealing material and the oil bath. The Engineer may require a demonstration that the equipment will consistently produce a joint sealant of required pouring consistency.

Equip the kettle with a pressure pump, hose, and nozzle that can place the joint sealant to the full depth of the joint and completely fill the joint. Do not use direct flame heat on the nozzle.

- B. **Base Preparation.** Construct and maintain the base to the required line, grade, and cross section, in accordance with subsection 302.03, before pavement placement. Prepare the base, and allow the Engineer to test and accept the base before setting forms or slip-form paving.

Verify that the paving equipment will maintain the grade tolerance specified for the pavement. If the prepared base is damaged by construction equipment, reconstruct the grade and cross section in accordance with subsection 302.03.C, or as directed by the Engineer, before placing the concrete, at no additional cost to the Department.

- C. **Placing Forms.** Trim the compacted base close to the staked grade using base preparation equipment. Check the base for line and grade, and correct irregularities before placing the forms. Compact the base outside the area to be paved, to support the forms.

Clean forms of hardened concrete or mortar that would alter the shape or finish elevation of the anticipated concrete placement. Set forms, providing uniform bearing of the forms directly on the base throughout their length and width. Securely join, lock, stake, and brace each form segment. Do not allow vertical movement to exceed $\frac{1}{8}$ inch and horizontal movement to exceed $\frac{1}{4}$ inch during concrete placement.

After the forms are set, provide time for the Engineer to check them. If requested by the Engineer, fabricate string lines for checking line and grade. Adjust form lines that vary from the staked line by more than $\frac{1}{2}$ inch, or from the staked grade by more than $\frac{1}{8}$ inch.

Treat the inside of all forms with a release agent that will not discolor or adversely affect the concrete. Do not allow the release agent to come in contact with steel reinforcement, lane ties, or existing concrete surfaces.

- D. **Placing Concrete.** Set structure castings to grade and alignment before, or during, concrete placement. The boxing-out method for concrete base course and temporary concrete pavement will be allowed. Clean structure castings to allow adhesion of the concrete.

Place concrete on a moist base. Do not place concrete on a frozen base or an unstable base.

Keep the top of the forms clean and free of concrete during placing and finishing.

Inspect vertical surfaces of previously placed concrete and the adjacent grade, and remove material that would prevent the adjoining concrete pour from consolidating or conforming to the plan dimensions.

If an open-graded base is used, inspect the graded base for contamination from fines or debris, prior to paving. If the Engineer determines that contaminated material requires removal or replacement, remove and replace at no additional cost to the Department.

When the Engineer determines that damage occurs to the base course from hauling units, discontinue production until the cause of the damage has been evaluated and corrected.

Spread and strike off the concrete as soon as it is deposited on the base and avoid segregation. Consolidate the concrete with internal vibrators. Provide additional vibration as needed to properly consolidate concrete adjacent to the faces of fixed forms and next to transverse dowel bar assemblies. Do not use vibrators for flowing or spreading concrete.

When using the slip-form method, vibrate concrete for the full width and depth of the pavement. Where placing the concrete in two layers, the consolidation may occur after placing the top layer.

Continually monitor the operation of vibrators mounted on the paving machine. Do not commence paving until it is demonstrated to the satisfaction of the Engineer that vibrators are operating in accordance with the manufacturer's specifications. If a vibrator malfunctions during paving, discontinue paving operations and correct the malfunction. Resume paving when malfunctions are corrected and the Engineer approves.

Cease vibration and tamping when the paving equipment stops.

Provide a continuous paving operation. The Engineer may stop production if there is not sufficient equipment or labor to keep pace with the other paving operations. When placing the concrete in two layers, place the top layer of concrete within 30 minutes of placing the bottom layer. Place a transverse end-of-pour joint (Symbol H) when unavoidable interruptions of concrete placement occur that are longer than 60 minutes from the time the concrete is batched until final finishing of the concrete surface.

Operate equipment to prevent damage to pavements and bridge decks and to maintain the required grade in transitioning from the pavement to the deck.

Do not allow vehicles or equipment, other than joint saws or ride-quality measurement equipment, on new pavement or portions of new pavement until the concrete reaches a strength in accordance with subsection 104.11.

Keep existing pavements clean of materials that may interfere with finishing operations or cause damage to the concrete surface.

Where placing slip-form pavement in two layers, each side of the first layer may be cast narrower than the width of the proposed pavement slab by 3 inches and at least twice the largest dimension of the concrete aggregate, but not more than 6 inches. Cast full-depth pavement at the edges with the second layer.

Unless otherwise specified, finish concrete placed each day during daylight, or provide artificial light at no additional cost to the Department, as approved by the Engineer.

- E. **Placing Reinforcement.** Place reinforcement that is free of loose rust and other contaminants.

- 1. **Welded Wire Fabric.** Place steel welded wire fabric for concrete pavements from a reinforcement bridge or by other methods that will not contaminate the concrete as approved by Engineer.

2. **Bar Reinforcement.** Place steel bar reinforcement for concrete bridge approach pavements in accordance with subsection 706.03, *MDOT Standard Plan R-45* series, and as shown on the plans.
- F. **Constructing Joints.** Install epoxy-coated lane ties or deformed bars in accordance with Standard Plan R-41 series.

1. **Longitudinal Lane-Tie Joints with Straight Tie Bars (Symbol D and Symbol S).** Place longitudinal lane-tie joints with straight tie bars (Symbol D and S) in accordance with *MDOT Standard Plan R-41* series. Use Department-approved chairs or mechanical devices to support bars. Do not place lane-tie bars in the concrete by hand methods.

Unless otherwise required in the contract, installation of lane-tie bars is not required for temporary concrete pavement.

2. **Longitudinal Bulkhead Joints (Symbol B).** Place longitudinal bulkhead joints (Symbol B) in accordance with *MDOT Standard Plan R-41* series. Protect the free-edge longitudinal joint until adjacent pavement is placed. Install the bent bars to allow consolidation around the bars without causing concrete slumping at the edges. Straighten bent tie bars after the concrete has gained required strength. Straighten tie bars to run parallel to the surface of the pavement and perpendicular to the edge of the pavement. Inspect the bars to determine whether the epoxy coating is damaged after straightening the bars. Repair tears or loosening of the epoxy coating within 6 inches of the joint face using the coating material recommended by the coating manufacturer.
3. **Pull-out Resistance Testing for Adhesive Anchored Lane-Tie Bars.** Pull-out resistance testing is required for lane-tie bars that are adhesive anchored into the hardened concrete. Pull-out resistance testing is not required for lane-tie bars that are cast into the fresh concrete.

Lane-tie bar pull-out resistance must meet the requirements in Table 602-1. If the test results for the lane-tie bars from the first day of placement meet the requirements of Table 602-1, the Engineer will determine the need for additional testing.

If the average pull-out resistance is less than the minimum requirements in Table 602-1, provide a plan to the Engineer for approval. The plan should detail how additional epoxy-anchored lane-tie bars will be added to provide proper load transfer. Install anchored lane-tie bars in accordance with the approved plan at no additional

cost to the Department. Do not place adjacent pavement until the Engineer tests the additional lane-tie bars.

The Engineer may waive verification tests for projects with less than 1,000 feet of longitudinal bulkhead joints.

**Table 602-1:
Lane-Tie Pull-Out Resistance**

Distance from Joint Being Constructed to Nearest Free Edge of Completed Pavement^(a)	Average Pull-out Resistance (lb minimum per foot of joint)^{(b),(c)}
≤12 feet	2,200
>12 feet through 17 feet	3,200
>17 feet through 24 feet	4,500
>24 feet through 28 feet	5,200
>28 feet through 36 feet	6,800
≥36 feet	— ^(d)

(a) Includes combinations of tied lane widths, valley gutter, curb and gutter, or concrete shoulder.

(b) Slippage must not exceed $\frac{1}{16}$ inch.

(c) Refer to the *Materials Quality Assurance Procedures Manual* for inspection procedure.

(d) As directed by the Engineer.

4. **Transverse Joints.** Construct transverse contraction, expansion, and plane-of-weakness joints in pavements as shown on the *MDOT Standard Plans*.

Unless otherwise shown on the plans, construct transverse joints perpendicular to the pavement centerline.

Where placing pavement in partial-width slabs, place transverse joints in line with like joints in the adjacent slab. Where widening existing pavements, place transverse joints in line with like joints in the existing pavement and in line with “working” cracks that function as joints, or as directed by the Engineer.

Provide load-transfer assemblies manufactured in accordance with the *MDOT Standard Plans*. The Engineer will reject damaged, deformed, or nonconforming load transfer assemblies. Stake the load transfer assemblies in place. Do not cut the shipping tie wires. Allow time for the Engineer to check the assemblies for condition, line, and grade before placing concrete. Permanently mark dowel bar locations on the vertical face of the plastic concrete pavement to accurately identify and locate joints for subsequent sawing.

For expansion joints, equip the free end of the bar with a close-fitting cap in conformance with the *MDOT Standard Plans*.

Where using more than one section of premolded joint filler in a joint, tightly butt the sections together. Place the bottom edge of the premolded filler in contact with the base and the top edge at the required depth below the surface of the pavement. Place the expansion joint filler perpendicular to the surface and the centerline of the pavement.

Construct end-of-pour joints in accordance with the *MDOT Standard Plans*.

If using a DBI to install load transfer bars, space the bars in accordance with *MDOT Standard Plan R-40* series. Place and consolidate the pavement full-depth before inserting the dowel bars. Permanently mark dowel bar locations on the vertical face of the plastic concrete pavement for accurate identification and location of joints for subsequent sawing.

Insert dowel bars into the full-depth plastic concrete, and consolidate the concrete around the dowel bars, leaving no voids. Do not use hand-held vibrators. Align dowel bars in the vertical and horizontal planes to within $\frac{1}{2}$ inch for the entire length of the bar. Center dowel bars longitudinally within 2 inches of the location of the transverse joint shown on the plans.

Verify the inserted dowels meet the required tolerances. The Engineer will witness these measurements. Provide documentation, if requested by the Engineer. Perform daily wet checks of the dowel bars at a minimum frequency of one wet check every 500 feet and as required by the concrete QC plan. Mark and replace joints that are out of tolerance at no additional cost to the Department.

Locate the night header at a transverse joint location. Place a test joint beyond the night header to remove for testing. Saw the test joint full-depth, to expose the ends of the dowels, 14 inches wide over the center of the joint (7 inches each side of the center of the joint), and remove the test header for inspection of the dowel bar placement before restarting the concrete pavement operation. The minimum width of area to be removed must equal the width of the slab being placed on the project. Install dowels in the night header in drilled and adhesive anchored, or preformed holes after removal of the test joint. If the Contractor uses a continuous paving operation that does not stop, the Engineer will establish the test joint location. Unless otherwise directed by the Engineer, a minimum of three acceptable test joints are required per direction of paving for the project.

Saw transverse contraction and expansion joints in accordance with subsection 602.03.N.

5. **Intersection Joint Layout.** Develop a plan showing the intended layout of the joints, including clear labeling of proposed joint types. The intersection joint layout plan must be submitted to the Engineer for review a minimum of 7 days prior to concrete placement. Any comments or proposed changes to the plan will be returned for revision to produce an approved joint layout plan prior to concrete placement.

Construct intersection joints in pavements as shown on the approved intersection joint layout plan.

Saw intersection joints in accordance with subsection 602.03.N.

- G. **Screeding.** Screed and consolidate concrete pavement to achieve the final cross section shown on the plans. Use machine methods that avoid material segregation.

The Engineer may allow the use of manual methods for concrete pavement gaps less than 160 feet long and no greater than one lane width wide, or if the pavement is entirely concrete base course.

Do not use water to enhance finishing operations.

- H. **Finishing Surface.** Screed or extrude the finished surface to a smooth, sealed, and uniform appearance in accordance with the final cross section shown on the plans.
- I. **Straightedge Testing, Surface Correction, and Edging.** While the concrete is still plastic, test the slab surface and structure castings for compliance with the required grade and cross section using a 10-foot straightedge, or other method if approved by the Engineer.

If high or low spots exceed $\frac{1}{8}$ inch over 10 feet, suspend paving operations and correct the finishing procedures. Correct high or low spots in pavements that exceed the tolerance and obtain the Engineer's approval before resuming paving operation.

The Engineer will evaluate high or low spots in the hardened concrete slab surface, including structure castings, that exceed $\frac{1}{2}$ inch over 10 feet, or $\frac{3}{4}$ inch over 50 feet, in accordance with subsection 104.04.

In locations where the hardened concrete slab interfaces with either a newly constructed pavement, sleeper slab, approach slab, or expansion joint, the Engineer will evaluate high or low spots on either surface, including the interface between the two surfaces, that exceed $\frac{1}{2}$ inch over 10 feet in accordance with subsection 104.04.

Correct high or low spots in pavements that exceed these tolerances at no additional cost to the Department.

Correct edge settlement that exceeds $\frac{3}{8}$ inch before the concrete hardens. Suspend paving if edge settlement exceeding $\frac{1}{4}$ inch continues for at least 10 feet, and make corrections before resuming paving.

Do not leave overhanging projections on pavement edges, except on temporary concrete pavement.

- J. **Ride Quality.** Provide ride quality as required by the contract.
- K. **Texturing.** When the pavement sets and will maintain a texture, drag the surface longitudinally using one or two layers of damp burlap. Maintain contact between the burlap and the concrete surface across the entire width of newly placed concrete.

Immediately after dragging, groove pavement surfaces other than concrete base courses and shoulders. Unless otherwise shown on the plans, use a steering-controlled machine to orient the grooves parallel to the longitudinal joint. Prevent noticeable wander, overlap, or wave pattern in the grooves. Do not allow the groove edges to slump at the edges or severely tear the concrete surface. Place grooves with a width and depth of $\frac{1}{8}$ inch, with a tolerance of $\frac{1}{32}$ inch, spaced $\frac{3}{4}$ inch on center with a tolerance of $\frac{1}{16}$ inch. Do not groove the pavement surface within $1\frac{1}{2}$ inches of longitudinal joints. Provide a mean texture depth from 0.04 inch to 0.10 inch, in accordance with ASTM E965.

For areas requiring turf-drag texturing, produce the texture and required mean texture depth by longitudinally dragging an artificial turf material to produce a uniform pattern parallel to the centerline. Maintain continual and uniform contact with the plastic concrete over the entire area being textured. Periodically clean turf material to maintain a uniform texture. Provide a mean texture depth at least 0.03 inch, in accordance with ASTM E965.

For miscellaneous pavement, the use of a manual texturing device with a texture rake at least the same width as the plastic concrete pavement will be allowed.

When transverse grooving is required, orient the grooves perpendicular to the centerline and form the grooves in the plastic concrete. Do not allow the grooves to slump at the edges or severely tear the concrete surface. Place grooves with a width and depth of $\frac{1}{8}$ inch, with a tolerance of $\frac{1}{32}$ inch, spaced $\frac{3}{4}$ inch on center, with a tolerance of $\frac{1}{16}$ inch.

Texture the plastic concrete before applying curing compound. If the Engineer determines that the texturing operations are delaying the

application of the curing compound, stop the texturing operation, and complete the application of curing compound.

If texturing is not complete before placing curing compound or if the pavement is not textured as required, complete the surface texturing of the hardened concrete, at no additional cost to the Department, after the pavement achieves the minimum required class design strength. Correct pavement surfaces by grooving the hardened concrete longitudinally with a width and depth of $\frac{1}{8}$ inch and a tolerance of $\frac{1}{32}$ inch, spaced $\frac{3}{4}$ inch on center with a tolerance of $\frac{1}{16}$ inch on center. Submit a corrective action plan, including collection and disposal of the residue from retexturing, for the Engineer's approval.

- L. **Stenciling Pavement.** After texturing, stencil survey station numbers into the pavement surface. Stencil station numbers 16 inches from the edge of the pavement. Place numbers perpendicular to the centerline of the roadway, legible from a vehicle traveling in the direction of traffic. On two-way roads, stencil station numbers to read in the direction of stationing.

Stencil the month, day, and year into the concrete pavement at the beginning and end of each day's pavement operation, near the edge of the slab opposite the edge used for stationing. Place the date so it can be read if facing in the direction of pavement placement.

Do not stencil concrete base courses and temporary pavements.

Mark underdrain outlets in concrete shoulders, in accordance with subsection 404.03.F. Stencil the marker into the concrete surface, after texturing.

- M. **Curing.** Curing operations will take precedence over texturing in accordance with subsection 602.03.K.

Cure the concrete as soon as the free water leaves the surface of the pavement. Coat and seal the pavement surface and sides of slip-formed pavement with a uniform layer of membrane curing compound.

Apply one coat of curing compound on non-grooved surfaces and two coats on grooved surfaces. Apply at least 1 gallon per 25 square yards of surface for each coat. Apply the second coat after the first coat dries, but do not allow more than 2 hours between coats.

Maintain a thoroughly mixed compound in accordance with the manufacturer's recommendation. Do not thin curing compound.

For miscellaneous concrete pavement more than one lane wide, apply the compound from a foot bridge, if using a manually operated pressure-type sprayer.

Immediately reapply curing compound to surfaces damaged by rain, joint sawing, Contractor foot traffic, or other activities.

If fixed-forms are removed within the 7-day curing period, coat the sides of the pavement with curing compound immediately after removing the forms.

If using cold-weather protection during the curing period, curing compound may be omitted if approved by the Engineer. Apply curing compound immediately after removing cold-weather protection.

Repair or replace concrete showing injury or damage due to inadequate curing at no additional cost to the Department.

- N. **Sawing Joints.** Saw joints as shown on the *MDOT Standard Plans*. The use of a concrete saw on new pavement to saw the joints is allowed. The water supply truck is not allowed on new pavement until the pavement has attained the strength specified in subsection 104.11.

Immediately stop sawing operations if sawing causes raveling, spalling, or damage to the concrete surface. Continue to monitor the concrete hardness before resuming sawing operation.

1. **Longitudinal Joints.** Saw longitudinal joints (Symbol D). Start sawing operation after the concrete pavement hardens but before random cracks develop in the concrete pavement.
2. **Transverse Contraction and Expansion Joints.** Construct the joint groove in expansion joints as shown on the *MDOT Standard Plans*. Flush loose concrete and slurry from the groove and the immediate area.

If the required seal is not installed within 7 days of final sawing, temporarily seal the joint groove with a Department-approved material or device to prevent the infiltration of foreign material.

Install either the permanent seal or a temporary seal before allowing vehicles to travel over the full-width joint grooves.

Saw joints in two stages, in accordance with the following:

- a. Place a relief cut directly over the center of the load transfer assembly or over the preformed joint filler. Make the relief cut after the concrete hardens and will not excessively ravel or spall, but before random cracks develop in the concrete pavement. Immediately stop sawing if sawing operation causes excessive raveling or spalling, and continue to monitor the concrete hardness before resuming sawing operations. Do not allow traffic over the expansion-joint relief cuts.

- b. Center the joint groove over the relief cut. Immediately stop sawing if sawing operation causes excessive raveling or spalling, and continue to monitor the concrete hardness before resuming sawing operations. Maintain the curing of the concrete near the joint and, if required, install the permanent joint sealant or place temporary cover material. Give second-stage sawing of expansion joints priority over second-stage contraction joint sawing, if higher pavement temperatures are forecast.

If proposing an alternative method for sawing, submit a plan to the Engineer for approval. Alternate methods will not be allowed if they cause spalling, raveling, and random cracks in the concrete pavement.

Repair raveling or spalling in accordance with subsection 602.03.P. Remove and replace random cracked panels as directed by the Engineer, at no cost to the Department.

The *MDOT Standard Plans* specify the location of the transverse joint in the pavement, shoulder, curb and gutter, valley gutter, or base course, if the joint requires a load transfer assembly, expansion joint filler, or both, and the type of sealant or seal required.

- O. **Pavement Thickness.** The Department will determine payment in accordance with subsection 602.04. Coring for QC purposes is not allowed unless approved by the Engineer.
- P. **Patching Joints.** After sawing and cleaning the joints, inspect for spalls and voids. Remove loose, unsound, or damaged concrete as directed by the Engineer. Repair joints in concrete base course and temporary concrete pavement for intermediate and major spalls. Perform all spall repairs at no additional cost to the Department.
 1. **Minor Spalls.** Minor spalls or voids are defined as those that do not exceed 1 inch beyond the vertical joint face shown in the *MDOT Standard Plans*.

Saw cut spalls parallel to the joint groove at the outer extremity of the spalled area. Sandblast the spalled concrete surface. Blow the patch clean with a jet of oil-free compressed air.

Clean concrete surfaces according to subsection 602.03.R.

Seal minor spalls according to subsection 602.03.S.
 2. **Intermediate Spalls.** Intermediate spalls are defined as those that do not exceed 4 inches in width by 2 feet in length along the direction of the joint and are not greater than 4 inches deep. No more than 3 non-continuous linear feet of intermediate spall is permitted per

transverse joint, or per panel for longitudinal joint, or as determined by the Engineer.

Saw cut spalls parallel to the joint groove at the outer extremity of the spalled area. Cut at least 2 inches deep. Chip the concrete out to the saw cut to form a vertical face at the back of the repair area. Cut the two ends of the repair area to form vertical faces. Sandblast the entire area to remove loose particles. Blow repair area clean with a jet of oil-free compressed air to remove the sand and other loose material.

Select a material for intermediate spall repair according to subsection 914.05.

3. **Major Spalls.** Major spalls are those exceeding the dimensional thresholds described for intermediate spalls. Repair major spalls according to *MDOT Standard Plan R-44* series.

- Q. Repair of Longitudinal Joints and Edges.** Patch spalls that occur between adjacent lanes of concrete pavement and at edges in accordance with subsection 602.03.P.

Where a concrete pavement abuts an HMA surface, patch spalls that extend more than 1 inch from the vertical joint face and more than 1 inch below the surface of the pavement. If the cumulative total of spall lengths exceeds 20 feet per mile of pavement joint, patch spalls less than 1 inch from the vertical joint face and more than 1 inch below the surface of the pavement.

The Engineer will direct the repair of spalls greater than 36 square inches within 10 feet of longitudinal joint or edge. Remove and replace the pavement if so directed by the Engineer at no additional cost to the Department.

- R. Cleaning Joints.** Clean joints, including the surface of the pavement next to the joint groove, with appropriate tools and equipment to remove slurry, stones, or other loose material.

Ensure the vertical faces of the prepared joint meet the concrete surface profile 2 (CSP 2) as defined by the International Concrete Pavement Repair Institute. Joints must be clean and dry with no sign of debris, residue, and surface moisture prior to installing joint sealant material.

- S. Sealing Joints.** Seal longitudinal and transverse joints as shown on the plans.

Do not use artificial heat to dry joints before sealing.

Seal the joints immediately after cleaning. Verify that the joint surfaces are dry before sealing. Place sealant when the concrete temperature is at least 40°F and rising without the use of artificial heat.

Melt sealant in a heating kettle; do not heat directly. Do not use sealants that are heated to more than the safe heating temperature recommended by the manufacturer.

Apply hot-poured joint sealant using a pressure applicator with a nozzle that extends into the groove. Remove sealant from the surface of the pavement. Before allowing traffic over the sealed joint, cure the sealant to resist pickup.

T. Weather and Temperature Limitations

1. **Protection Against Rain.** Protect the concrete pavement from damage by rain.
2. **Protection from Cold Weather.** Protect the concrete pavement from freezing until it attains a compressive strength of at least 1,000 psi. Remove and replace concrete slabs damaged by cold weather, as directed by the Engineer, and at no additional cost to the Department.
3. **Cold Weather Limitations.** Do not place concrete pavement until the ambient air temperature away from artificial heat is at least 25°F and rising, unless otherwise approved by the Engineer. Do not place concrete pavement if portions of the base, subbase, or subgrade layer are frozen, or if the grade exhibits poor stability from excessive moisture. Protect the concrete surfaces using insulating blankets or polystyrene insulation with a minimum R-value of 7.0 if the National Weather Service forecasts air temperatures below 40°F for more than 8 consecutive hours during the curing period. Plastic sheeting may be used instead of insulating blankets or polystyrene insulation if the National Weather Service forecasts air temperatures above 32°F during the curing period.
4. **Hot Weather Limitations.** Protect concrete pavement during hot weather as required by the concrete QC plan. Protect the concrete pavement if the rate of evaporation is equal to or greater than 0.20 psf per hour, in accordance with Figure 706-1.

Use equipment, approved by the Engineer, for determining the relative humidity and wind velocity at the concrete pavement site.

5. **Concrete Temperature Limitations.** At the time of concrete placement, ensure a concrete temperature from 45°F to 90°F.

602.04. Measurement and Payment

Pay Item	Pay Unit
Conc Pavt, Reinf, ___ inch.....	Square Yard
Conc Pavt, Bridge Approach, Reinf.....	Square Yard
Conc Pavt, Bridge Approach, Reinf, High Performance	Square Yard
Conc Pavt, Nonreinf, ___ inch	Square Yard
Conc Pavt, Nonreinf, ___ inch, High Performance.....	Square Yard
Conc Pavt with Integral Curb, Reinf, ___ inch.....	Square Yard
Conc Pavt with Integral Curb, Nonreinf, ___ inch.....	Square Yard
Conc Pavt, Misc, Reinf, ___ inch	Square Yard
Conc Pavt, Misc, Nonreinf, ___ inch	Square Yard
Conc Pavt, Misc, Nonreinf, ___ inch, High Performance	Square Yard
Conc Pavt, Reinf, ___ inch, Temp.....	Square Yard
Conc Pavt, Nonreinf, ___ inch, Temp.....	Square Yard
Conc Base Cse, Reinf, ___ inch	Square Yard
Conc Base Cse, Nonreinf, ___ inch	Square Yard
Shoulder, Reinf Conc	Square Yard
Shoulder, Nonreinf Conc	Square Yard
Shoulder, Nonreinf Conc, High Performance	Square Yard
Shoulder, Freeway	Square Yard
Conc Pavt, Ovl, Furnishing and Placing	Cubic Yard
Conc Pavt, Ovl, Furnishing and Placing, High Performance	Cubic Yard
Conc Pavt, Ovl, Finishing and Curing.....	Square Yard
Conc Pavt, Ovl, Finishing and Curing, High Performance ..	Square Yard
Conc Pavt, Ovl, Misc, Furnishing and Placing	Cubic Yard
Conc Pavt, Ovl, Misc, Furnishing and Placing, High Performance	Cubic Yard
Conc Pavt, Ovl, Misc, Finishing and Curing.....	Square Yard
Conc Pavt, Ovl, Misc, Finishing and Curing, High Performance	Square Yard
Pavt Gapping	Foot
Joint, Contraction, (type)	Foot
Joint, Contraction, (type), Intersection.....	Foot
Joint, Expansion, (type).....	Foot
Joint, Expansion, (type), Intersection	Foot
Joint, Plane-of-Weakness, (type)	Foot
Joint, Plane-of-Weakness, (type), Intersection.....	Foot
Conc, Grade ___.....	Cubic Yard

- A. **Concrete Pavement and Base Course.** The Engineer will measure, and the Department will pay for, concrete pavement and base course by area, based on plan quantities in accordance with subsection 109.01. The Department will establish pay items based on the type of pavement

installed, the pavement thickness required, and whether reinforcement is required.

The Engineer will measure concrete pavement with integral curb by area, including the curbs.

The Engineer will measure transition areas between concrete valley gutter and concrete curb and gutter, and concrete valley gutter cast integrally with concrete pavement at the apex of gore areas, by dividing the area in half and measuring each half using the units of adjacent pay items.

The unit prices for other pavement and base course pay items include the cost of concrete headers abutting bridges and track crossings constructed by thickening the pavement.

The unit prices for **Conc Pavt, Misc, Reinf; Conc Pavt, Misc, Nonreinf; Conc Pavt, Misc, Nonreinf, High Performance, Conc Pavt, Bridge Approach, Reinf; and Conc Pavt, Bridge Approach, Reinf, High Performance** of the thicknesses required, include the cost of additional concrete additives if concrete pavement for pavement gapping requires additives to meet minimum opening-to-traffic strength requirements.

B. Concrete Shoulder

1. **Shoulder, Reinf Conc; Shoulder, Nonreinf Conc; and Shoulder, Nonreinf Conc, High Performance.** The Engineer will measure, and the Department will pay for, **Shoulder, Reinf Conc; Shoulder, Nonreinf Conc; and Shoulder, Nonreinf Conc, High Performance** by area, based on plan quantities in accordance with subsection 109.01.
2. **Shoulder, Freeway.** The Engineer will measure, and the Department will pay for, **Shoulder, Freeway** based on plan quantities in accordance with subsection 109.01. If the Contractor uses concrete for the shoulder, the unit price for **Shoulder, Freeway** includes the cost of the transverse joints in the shoulder and the external longitudinal pavement joints.

C. Concrete Overlay

1. **Concrete Pavement, Overlay Furnishing and Placing.** The Engineer will measure, and the Department will pay for, **Conc Pavt, Ovly, Furnishing and Placing; and Conc Pavt, Ovly, Furnishing and Placing, High Performance** on concrete pavements and shoulders, including providing and placing the concrete mixture, by volume. The Engineer will determine the volume based on in-place quantities.

2. **Concrete Pavement, Overlay Finishing and Curing.** The Engineer will measure **Conc Pavg, Ovly, Finishing and Curing** and **Conc Pavg, Ovly, Finishing and Curing, High Performance** in place. The unit price for **Conc Pavg, Ovly, Finishing and Curing** and **Conc Pavg, Ovly, Finishing and Curing, High Performance** includes the cost of finishing and curing concrete pavements and shoulders, finishing and curing the concrete overlays, and constructing longitudinal joints.

The Engineer will measure, and the Department will pay for, constructing transverse joints, in accordance with subsection 602.04.E, and for repairing and removing the existing pavement, in accordance with subsection 603.04.B.

3. **Concrete Pavement, Overlay, Miscellaneous Furnishing and Placing and Concrete Pavement, Overlay, Miscellaneous Finishing and Curing.** The unit prices for **Conc Pavg, Ovly, Misc, Furnishing and Placing; Conc Pavg, Ovly, Misc, Furnishing and Placing, High Performance; Conc Pavg, Ovly, Misc, Finishing and Curing; and Conc Pavg, Ovly, Misc, Finishing and Curing, High Performance** include the cost of reconstructing ramps, ramp overlays, gore areas, and approach areas. The Engineer will measure, and the Department will pay for, **Conc Pavg, Ovly, Misc, Furnishing and Placing** and **Conc Pavg, Ovly, Misc, Furnishing and Placing, High Performance** in accordance with subsection 602.04.C.1. The Engineer will measure, and the Department will pay for, **Conc Pavg, Ovly, Misc, Finishing and Curing** and **Conc Pavg, Ovly, Misc, Finishing and Curing, High Performance** in accordance with subsection 602.04.C.2.

Substituting higher grades of concrete for lesser grades of concrete will be allowed at no additional cost to the Department.

- D. **Pavement Gapping.** The Engineer will measure **Pavg Gapping** by the length parallel to the centerline of the project from the beginning of concrete to the end of concrete, within the gapped section. The Engineer will measure each individual lane of gapped concrete pavement separately. The unit price for **Pavg Gapping** includes the cost of interrupting paving operations, moving back to pave the gap, and maintaining cross traffic.

The unit prices for other pay items include the cost of gapping curbs, curb and gutter, gutters, driveways, and sidewalks.

- E. **Joints.** The unit prices for other pay items include the cost of transverse end-of-pour joints (Symbol H) and transverse plane-of-weakness joints

(Symbol U). The Department will pay for other transverse joints by the length, based on plan dimensions, for the type of joint required.

The unit price for the transverse contraction, transverse expansion, transverse plane-of-weakness, and intersection joints include the cost of the following:

1. Providing required joint materials such as load transfer assemblies, expansion joint fillers, and joint seals or sealants;
2. Providing a joint layout detail plan, if required;
3. Sawing, forming, and cleaning the joints;
4. Providing and applying bond breaker, if required; and
5. Providing and placing poured joint sealant.

The Engineer will measure, and the Department will pay for, expansion or contraction joints for concrete shoulders, shown on the plans, based on plan dimensions.

The unit prices for other pay items include the cost of internal and external longitudinal joints.

- F. Price Adjustment for Pavement, Shoulder, and Base Course Based on Thickness and Depth of Reinforcement.** The Engineer will core the concrete pavement before final acceptance to determine the thickness of the concrete pavement, and if required, the depth of reinforcement below the pavement surface. The Engineer will only measure the top layer of steel for depth of concrete cover for concrete pavements with two layers of required reinforcement.

The Engineer will not core the following:

1. Temporary concrete pavement;
2. Pavement within 4 feet of an obstruction;
3. Pavement areas less than 300 square yards; or
4. Pavement less than 3 feet wide.

The Engineer will determine concrete pavement units, core locations, and evaluate cores in accordance with Michigan Test Method (MTM) 201.

The Department will adjust the contract unit price for areas of concrete pavement where thicknesses or reinforcement locations exceed required tolerances. The Engineer will use Table 602-2 to classify cores and determine price adjustments according to concrete pavement thickness. The Engineer will use either Table 602-3A or Table 602-3B to classify cores and determine price adjustments according to steel depth. The

Department will apply these adjustments cumulatively to the evaluated pavement unit.

5. **Initial Core.** The Engineer will classify each initial core with a one- or two-letter core-type code. The first letter (A, B, or C) represents the thickness classification in accordance with Table 602-2 and the second letter (X, Y, or Z), represents the steel depth classification in accordance with Table 602-3A.

If the Engineer classifies an initial core from a concrete pavement unit as Type AX, indicating both thickness and steel depth are within required tolerances, the Department will not apply an adjustment and the Engineer will take no additional cores.

6. **Additional Cores.** If the Engineer does not classify an initial core from a concrete pavement unit as Type AX, the Engineer will take additional cores. The Department will only consider the dimensions not within the A or X range for adjustment based on subsequent cores. The Engineer will decide whether to accept the work, make a price adjustment of up to 100%, or direct the Contractor to remove and replace concrete pavement, based on the initial and additional cores.

7. Price Adjustment for Thickness

- a. **Initial Core Type A.** The Department considers a Core Type A to have a thickness within the required tolerances. The Engineer will not take additional cores to measure thickness, and the Department will not apply a price adjustment to the concrete pavement unit.
- b. **Initial Core Type B.** The Department considers a Core Type B to deviate from the design thickness as shown in Table 602-2. The Engineer will take two additional cores and measure the thickness.

The Engineer will calculate the average thickness for the concrete pavement unit. In determining the average thickness, the Engineer will record measurements of individual cores that exceed the required pavement thickness by more than $\frac{1}{4}$ inch as the required thickness plus $\frac{1}{4}$ inch.

The Department will determine the unit price adjustment using the average thickness rounded to the nearest 0.1 inch, and Table 602-2.

- c. **Initial Core Type C.** The Department considers a Core Type C to deviate from the design thickness by more than 1.1 inches.

The Engineer will take straddler cores to determine the area of deficiency.

The Engineer will establish a new initial core for the concrete pavement unit, excluding the deficient area, and repeat the evaluation and calculation for the concrete pavement thickness.

Remove and replace deficient areas in accordance with subsection 602.04.F.5.

8. **Price Adjustments for Steel Locations within the Pavement.** The Department will consider two variables when considering price adjustments for steel depth: the steel location relative to the pavement surface and the deviation of the steel location from the allowable depth range. The Department will determine both and apply only the larger of the two deviations from the requirements in Table 602-3A and Table 602-3B.

- a. **Initial Core Type X.** The Department considers a Core Type X to have reinforcement placed within the required tolerances for depth from surface of pavement. The Engineer will not take additional cores, and the Department will not make a price adjustment to the concrete pavement unit for reinforcement placement.
- b. **Initial Core Type Y.** The Department considers Core Type Y to contain reinforcement that deviates from the design depth. The Engineer will take two additional cores and measure the depth of steel from concrete pavement surface for each core.

The Engineer will calculate the average reinforcement depth.

The Engineer will use the average reinforcement depth and Table 602-3A to determine the price adjustment based on the location of the steel from the concrete pavement surface.

The Engineer will calculate the absolute deviation from the limits of the design depth range for each core, and the average absolute deviation from the required depth range.

The Engineer will use the average absolute deviation and Table 602-3B to determine the contract price adjustment based on deviation from required depth of steel range.

- c. **Initial Core Type Z.** The Department considers Core Type Z to contain reinforcement that deviates from the design depth by more than the required tolerance.

The Engineer will take straddler cores to determine the area of deficiency.

The Engineer will establish a new initial core for the concrete pavement unit, excluding the deficient area, and repeat the evaluation and calculation of depth of steel.

Remove and replace the deficient area in accordance with subsection 602.04.F.5.

9. **Remove and Replace.** If an initial core falls into either the Core Type C or Core Type Z category, the Engineer will delineate the deficient area by taking straddler cores at 5-foot intervals, longitudinally, in both directions from the initial core. The Department will consider defective areas separately from the remainder of the concrete pavement unit. The Contractor will remove and replace Core Type C and Core Type Z areas as directed by the Engineer. The Contractor will remove an area of pavement at least 10 feet long, for the full panel width. If the area designated for removal is within 15 feet of a transverse joint, the Contractor will remove the defective concrete pavement area to the joint. The Engineer will core and evaluate the replaced areas in accordance with subsection 602.04.F. If the concrete pavement is within the tolerances specified in Table 602-2, Table 602-3A, and Table 602-3B, the Department will pay for the replaced concrete pavement at the contract unit price.

**Table 602-2:
Price Adjustment for Concrete Thickness Deficiency**

Initial Core Type	Deficiency in Thickness (inch)	Price Adjustment
A	≤0.2	0%
B	0.3	-5%
B	0.4	-15%
B	0.5	-25%
B	0.6–1.0	-50%
C	≥1.1	-100% ^(a)

(a) Corrective action up to and including removing and replacing pavement

**Table 602-3A:
Price Adjustment for Depth of Steel from Pavement Surface**

Core Type	Tolerance on Depth of Reinforcement for Uniform Plan Thickness (inch) ^{(a),(b),(c)}					Price Adjustment
	7.75–8.50	8.75–9.50	9.75–10.50	10.75–11.50	Shoulder	
Z	0.0–0.9	0.0–0.9	0.0–0.9	0.0–0.9	0.0–0.9	–100% ^(d)
Y	1.0–1.9	1.0–1.9	1.0–1.9	1.0–2.4	1.0–2.4	–25% ^(d)
X ^(e)	2.0–4.0	2.0–4.5	2.0–5.0	2.5–5.5	2.0–4.0	0%
Y ^(e)	4.1–4.8	4.6–5.4	5.1–6.0	5.6–6.6	4.1–5.0	–25%
Y ^(e)	4.9–6.4	5.5–7.2	6.1–8.0	6.7–8.8	≥5.1	–50%
Z ^(e)	≥6.5	≥7.3	≥8.1	≥8.9	—	–100% ^(d)

- (a) If the contract requires a pavement reinforced with two layers of reinforcement, the Engineer will only measure the depth of the top layer of steel.
- (b) To determine pavement thicknesses, use the same depth range as the pavement the shoulder is tied to. Use the average shoulder thickness, if tapered.
- (c) Pavement or base course.
- (d) Corrective action up to and including removing and replacing pavement.
- (e) If a core length measures at least 0.2 inch over the plan thickness, increase the maximum depth range by one-half the excess core length over the plan thickness, round to the nearest 0.1 inch, in accordance with ASTM E29, and then add it to the range shown.

**Table 602-3B:
Price Adjustment for Deviation of Depth of Steel from Design Range Initial**

Core Type	Allowable Average Absolute Deviation from Design Depth of Reinforcement per Uniform Plan Thickness (inch) ^{(a),(b),(c)}					Price Adjustment
	6.5–7.5	7.75–8.5	8.75–9.5	9.75–10.5	11–13	
X ^(d)	0.0–0.5	0.0–0.5	0.0–0.5	0.0–0.5	0.0–0.5	0%
Y ^(d)	0.5–1.0	0.5–1.0	0.5–1.0	0.5–1.0	0.5–1.0	–10%
Y ^(d)	≥1.0	≥1.0	≥1.0	≥1.0	≥1.0	–25%
Design range	2.0–4.0	2.0–4.0	2.0–4.5	2.5–5.5	2.5–6.0	—

- (a) If the contract requires a pavement reinforced with two layers of reinforcement, the Engineer will only measure the depth of the top layer of steel.
- (b) To determine pavement thicknesses, use the same depth range as the pavement the shoulder is tied to. Use the average shoulder thickness, if tapered.
- (c) Pavement or base course.
- (d) If a core length measures at least 0.2 inch over the plan thickness, increase the maximum depth range by one-half the excess core length over the plan thickness, round to the nearest 0.1 inch, in accordance with ASTM E29, and then add it to the range shown.

Section 603. Concrete Pavement Restoration

603.01. Description

This work consists of restoring concrete pavement including the following:

- A. Removing and repairing portions of a concrete pavement, one lane wide and 100 feet long, or less, with reinforced and non-reinforced portland cement concrete, with the type of joint required;
- B. Diamond grinding and grooving portland cement concrete pavement;
- C. Resawing and sealing existing pavement joints;
- D. Sawing, cleaning, and sealing cracks in concrete pavements;
- E. Removing sections of concrete pavement, one lane wide and greater than 100 feet long in accordance with section 204 or subsection 603.03.B.1, as determined by the Engineer; and
- F. Replacing sections of concrete pavement one lane wide and greater than 100 feet long in accordance with section 602.

Refer to *MDOT Standard Plan R-44* series, *R-45* series, and the contract for details.

603.02. Materials

Provide material in accordance with the following sections:

Base Course Aggregate, 4G, 21AA, 22A	902
Curing Materials for Pavements	903
Insulating Blankets	903
HMA Mixtures for Restoring Shoulders	904
Steel Reinforcement	905
Joint Spall Repair Materials	914
Bond Breaker Material	914
Epoxy Coated Dowel Bars and Deformed Tie Bars	914
Joint Materials	914
Concrete, Grades, 3500, 3500HP	1004
Concrete, Grade P-NC	1006

Provide the concrete grade necessary to obtain the strength specified in Table 603-1 in the anticipated curing time, as determined by the Engineer. The Engineer will not require 28-day compressive strength test cylinders for concrete pavement repairs. The Engineer will perform flexural strength testing of the field cured test specimens. Acceptance will be based on the specimens attaining the minimum flexural strength prior to opening the concrete pavement repair to vehicular traffic.

**Table 603-1:
Opening to Traffic Strengths**

Anticipated Curing Time	Concrete Grade	Minimum Flexural Strength
<72 hours	Grade P-NC ^(a)	300 psi
≥3 days	Grade 3500, 3500HP	550 psi

- (a) The Engineer may approve the use of a non-chloride Type A water reducer, a non-chloride Type C accelerating, or a Type E water-reducing and accelerating admixture from the Qualified Products List to achieve the flexural strength requirements.

Provide coarse aggregate with no greater than 2.5% absorption in accordance with ASTM C127. Do not use calcium chloride admixture.

603.03. Construction

- A. **Equipment Requirements.** Use equipment necessary to perform the work in accordance with section 602 and the following:
1. **Drilling Machine.** Use a drilling machine and use methods to drill holes in the existing pavement vertical surfaces in accordance with the following:
 - a. Support the drill on rails that rest on the pavement surface at both ends of an 8-foot-long repair, or by other alignment methods approved by the Engineer, to ensure holes meet the requirements of *MDOT Standard Plan R-44* series;
 - b. Provide a drill that uses mechanically applied pressure for forward and reverse travel. Match the drill and pressure mechanism to drill the nominal depth holes to prevent cracking the concrete and spalling more than ½ inch horizontally or vertically; and
 - c. Equip the drill with a snug-fitting drill guide bushing, positioned against the face of the concrete to prevent eccentricity or overriding of the holes more than ¼ inch and to maintain the alignment tolerances.
 2. **Grout Dispenser**
 - a. **Bulk Grout Systems.** Use a grout dispenser and static mixing nozzle system recommended by the grout material manufacturer. Use a machine that proportions the components, mixes the components as they are extruded through the static nozzle, and deposits the mixed material in the back of the hole.

602.03.A.13. Equip the saw with a diamond blade with a diameter of 8 inches or less. Do not use routers.

- B. **Construction of Concrete Pavement Repair.** Construct concrete pavement repairs, 100 feet long, or less, in accordance with section 602, except as modified by this subsection.

Remove existing concrete pavement in sections at least 4 feet long. When the repair area is within 4 feet of an existing joint extend the repair to at least 1 foot beyond the joint. When the repair area is within 8 feet of an adjacent repair, remove the concrete pavement between the two areas, or as directed by the Engineer.

Control the grades by using the adjacent pavements. If the lane adjacent to a repair area is damaged, cast the repair area and open to traffic, then perform the removal and recasting of concrete repairs in the adjacent lane. The Engineer must approve the adjacent lane repair.

If the grade cannot be established by using adjacent pavements, provide grade control according to subsections 602.03 and 824.03.

1. **Removing Existing Pavement (Concrete Pavement Repair)**

- a. **Removing and Repairing Pavement Damaged by the Contractor.** Do not use removal equipment that damages the concrete pavement that will remain in place.

Repair spalls caused by the Contractor's operations in accordance with section 602 at no additional cost to the Department.

- b. **Planned Pavement Removal and Repair.** Remove part-depth or full-depth HMA patches, included in the portion of pavement being removed, as removal of concrete, without regard to additional effort that may be involved in the removal of dissimilar materials. Avoid disturbing the base during removal.

Perform shoulder removal using the same method as concrete pavement removal.

If the repair areas include repairing concrete curb, curb and gutter, or valley gutter, remove and replace the curbing adjacent to the repair and in line with the joints of the repair. If curbing removal leaves a section length, less than 6 feet from the saw cut to the nearest existing curb expansion joint, remove and replace the curb to the existing curb expansion joint.

Do not begin sawing more than 2 weeks before concrete pavement removal. Make straight, transverse saw cuts, at right angles to the centerline of the concrete pavement, within 1 inch

per lane width. Saw the longitudinal joint full-depth between adjacent lanes, ramps, shoulders, or curb and gutter. Use water, immediately after sawing, to flush slurry off the surface of the pavement.

Place concrete repairs the same day as the removal of existing concrete pavement. Remove concrete pavement between narrowly spaced saw cuts at the end of a slab with air hammers and hand tools. Except for utility cuts, install lifting devices in the slab. Lift the slab without disturbing the base. Clean the area with hand tools and remove slurry from sawed surfaces.

2. **Installing Dowels or Deformed Tie Bars in Transverse Joints.** Drill the vertical faces of the existing concrete pavement to allow the insertion of dowel bars or deformed tie bars. Re-drill holes that do not meet the required depth, diameter, and alignment, as directed by the Engineer, at no additional cost to the Department.

Clean drilled holes using oil-free compressed air with a minimum pressure of 90 psi. Fully insert the air wand into the holes.

Fill the clean drilled holes with an adhesive grout selected from the Qualified Products List. Fill the holes with adhesive grout to their full length to ensure the adhesive grout covers the embedded length of the inserted dowel bars or deformed bars. Slowly insert the bars into the holes using hand pressure and a twisting motion, until fully seated. Wipe away excess adhesive grout extruded around the bars. Do not proceed until the Engineer verifies the dowel bars are properly installed and the adhesive grout set.

Drill or punch holes in the joint filler used for expansion joints (Erg) to match the location of the holes in the existing pavement. Drill or punch the holes in the joint filler to produce neat, clean holes without excessively tearing the filler. After anchoring the dowel bars in place, install the joint filler and position it against the existing pavement. Extend the joint filler the full-depth of the repair and install flush with the existing pavement surface. Place the joint filler in one continuous length, so it covers the entire vertical surface and is in full contact with the sawed joint face, unless otherwise approved by the Engineer.

Coat the portions of dowel bars that extend beyond the face of the existing pavement or the joint filler with an approved bond-breaking coating. Do not coat deformed bars used with tied joints (Trg) or anchored-in-place lane ties with bond-breaking coating.

Install an approved expansion cap on the end of each dowel bar for expansion joints (Erg), after applying the bond breaker.

3. **Site Preparation.** If the plans show base corrections, excavate and backfill in accordance with section 205 and section 302. When the existing base is more than 2 inches lower than the required grade, correct the low base by adding base course aggregate and compacting to the required density and elevation. Increase the repair thickness, when the existing base is 2 inches or less below the required grade due to existing conditions or as a result of concrete pavement removal operations.

Set forms to the line and grade shown on the plans. Use one-piece forms for repairs 10 feet or less. For repairs greater than 10 feet, use forms that lock together or splice sections to provide a continuous form. Provide metal or wood forms. If using wood side forms, use lumber with a nominal thickness of at least 2 inches.

For reinforced concrete, position and support reinforcement in accordance with the *MDOT Standard Plans*.

4. **Longitudinal Joints.** If casting more than one lane in a single pour, construct longitudinal joints in line with the existing longitudinal joints. Construct longitudinal joints to a depth of one-third the thickness of the pavement by sawing or forming before opening to traffic.

Install lane ties in accordance with *MDOT Standard Plan R-44* series. Construct anchored-in-place lane ties in accordance with subsection 603.03.B.2, for deformed bars used with tied joints (Trg), except the use of handheld drills will be allowed.

5. **Transverse Joints.** If the contract requires an existing curb to be left in place, and there is an expansion space in the adjacent lane repair, saw an expansion joint (Esc) in the curb. Construct the joint in line with and equal in width to the expansion joint in the adjacent lane repair. Shape the joint filler to match the curb cross section.

6. **Placing Concrete.** Immediately before concrete placement, wet the faces of the existing pavement and the surface of the aggregate base with water.

Cast each repair in one continuous full-depth operation. Consolidate the concrete using a hand-held immersion-type vibrator, approved by the Engineer. Consolidate the concrete around dowel bars, deformed tie bars, and deformed lane tie bars.

7. **Finishing Concrete.** Strike off the surface flush with the existing pavement surface at least twice with a vibratory or roller screed. Do not float instead of striking off. For repairs 15 feet long or less, place the screed parallel to the centerline of the roadway. For repairs greater than 15 feet long, place the screed perpendicular to the centerline.

While the concrete is still plastic, check that the edges of the repair surface are flush with the edges of the existing concrete pavement, and verify the necessary grades are met.

For repairs 10 feet long or less, place the straightedge parallel to the pavement centerline with the ends resting on the existing pavement and draw the straightedge across the repair. Use a straightedge no greater than 6 inches longer than the repair. Keep the straightedge in contact with the existing pavement while drawing it across the repair. Correct high or low spots greater than $\frac{1}{8}$ inch, recheck the surface after making corrections, and eliminate irregularities.

For repairs greater than 10 feet long, use a straightedge in accordance with subsection 602.03.I. Make the first and the last measurement with half the straightedge resting on the existing pavement. Make the second and the next to last measurement with 2 inches to 3 inches of the straightedge resting on the existing pavement. Correct high or low spots greater than $\frac{1}{8}$ inch.

Before texturing, run an edger with a $\frac{1}{8}$ -inch to $\frac{1}{4}$ -inch radius along the perimeter of the repair. Remove forms after the concrete attains the strength required to prevent sagging or spalling upon removal of the forms.

8. **Texturing.** Texture the surface of the repair to match texturing on the adjacent concrete pavement.
9. **Stenciling.** Stencil the month and the year in each repair in accordance with subsection 602.03.L. If repair operations cause the removal of the existing stationing, stencil the station in the repair at the required location.
10. **Curing.** Apply the curing compound immediately after free water evaporates from the concrete pavement surface. Do not delay curing compound application for other work during concrete pavement placing and finishing operations.

Use white membrane curing compound, unless the repair requires a bituminous overlay. For repairs requiring bituminous overlay, use transparent curing compound. Apply the required curing compound in two coats, at a rate of at least 1 gallon per 25 square yards for each coat.

Stop concrete pavement placement if the curing compound application process fails to meet the requirements specified in this subsection. Maintain the placed and finished concrete in a continuously moist condition, using fog mist, until membrane curing compound is applied.

Alternative methods for keeping concrete continuously moist may be approved by the Engineer.

Reapply curing compound immediately to surfaces damaged by rain, joint sawing, Contractor foot traffic, or other activities.

Place insulated blankets to meet open-to-traffic requirements and protect the concrete pavement from weather damage. Provide insulated blankets at least 2 inches thick. When the air temperature falls below 50°F during the curing period, place blankets over the repaired area as soon as the curing compound dries. Secure edges and seams in the blanket to prevent heat loss. Protect the concrete until it attains the minimum flexural strength specified in Table 603-1.

Comply with the methods included in the QC plan for achieving open-to-traffic strength within the required time period.

The maturity method may be used at no additional cost to the Department, after submitting a plan to the Engineer for approval, to determine the in-place opening-to-traffic flexural strength. Make the necessary preliminary flexural strength versus opening-to-traffic time correlations before placing the concrete.

Cure test beams for open-to-traffic strengths in the same manner as the repair.

11. **Cleaning Joints.** Remove concrete from the top of any joint filler prior to blast cleaning. Immediately before sealing joints, blast clean, except tied joints (Trg), and then finish cleaning the joint again using oil-free compressed air with a minimum pressure of 90 psi to remove all debris. Insert a backer rod in the bottom of the contraction joint (Crg) reservoir after the final cleaning and before sealing.
12. **Sawing Joints.** Do not construct reservoirs for seals in the following joints:
 - a. Joints in base course repairs;
 - b. Joints in repairs constructed in preparation for HMA overlays; and
 - c. Reinforced anchored tied joints (Trg).

For all other joints and saw cuts in concrete pavements, shoulders, or gutters caused by overcutting, clean and seal using hot-poured joint sealant.

Before sealing joints, remove the joint filler from the top of the joint by sawing 1 inch wide and 1½ inches deep.

Saw joint reservoirs for the contraction joints (Crg).

Saw joint reservoirs for C2 joints and E2 joints after the concrete pavement attains the strength required to prevent excess raveling or spalling, but before random cracks develop. Forming of joint reservoirs is not allowed. Saw the initial relief cut and extend the reservoir to the plan width and depth in accordance with subsection 602.03.N, or initially saw to the width and depth shown on the plans.

13. Sealing or Resealing Transverse and Longitudinal Pavement Joints.

After completion of concrete pavement repairs, spall repairs, and pavement texturing, saw the transverse and longitudinal joints over the existing joint reservoir to remove existing sealant and produce a finished joint with two freshly sawed faces. Immediately after sawing, flush the joint reservoir with water to remove the slurry and debris. After final cleaning of the joints, insert a backer rod into the transverse joint, creating a 1:1 width-to-depth ratio for hot-poured sealant. Seal the joint reservoir to no greater than $\frac{1}{8}$ inch (after cooling) below the concrete pavement surface for transverse and longitudinal joints and in accordance with subsection 602.03.S.

14. HMA Shoulder Replacement. Before opening to traffic, restore HMA shoulders to the existing line and grade using a plant-mixed HMA, as directed by the Engineer. Replace cold patch mixtures for temporary patching with plant-mixed HMA, unless the plans show shoulder reconstruction as part of the project. Compact the HMA using mechanical or hand methods required for the size of the repair area. Fill the voids and compact flush with the surrounding shoulder. Place HMA at the required compaction temperatures.

Properly dispose of materials removed from the shoulder.

15. Opening to Traffic. The concrete pavement must attain the required minimum flexural strength, and all joints must be sawed and sealed in accordance with subsection 603.03.B before opening to traffic. The Engineer may allow traffic over the repair before the joints are cleaned and sealed.

C. Diamond Grinding and Grooving Concrete Pavement. Complete all pavement repair and joint restoration work, except sealing, before diamond grinding and grooving.

Diamond grind and groove concrete pavement in the longitudinal direction beginning and ending at lines perpendicular to the pavement centerline. Stop grinding and grooving if conditions cause water to freeze.

Do not disturb reflective pavement markers (RPMs). Taper grinding to the existing pavement surface within 2 inches of the RPM.

Texture at least 95% of the pavement surface unless otherwise directed by the Engineer. Extra depth grinding to eliminate minor depressions is not required.

After initial grinding, regrind faulted areas, greater than $\frac{1}{16}$ inch, at transverse cracks and joints, until faulting is less than $\frac{1}{16}$ inch.

Uniformly groove a parallel corduroy-type texture, consisting of grooves with a width of $\frac{1}{8}$ inch and a depth of $\frac{5}{32}$ inch with a tolerance of $\frac{1}{32}$ inch. The grooves must be spaced at $\frac{3}{4}$ inch on center with a tolerance of $\frac{1}{16}$ inch. Do not texture the pavement surface within $1\frac{1}{2}$ inches of longitudinal joints. Provide a mean texture depth from 0.04 inch to 0.10 inch, in accordance with ASTM E965.

Construct a uniform transverse slope with no depressions or misalignment greater than $\frac{1}{8}$ inch when checked with a 10-foot straightedge. The Engineer will not apply straightedge requirements across longitudinal joints or outside ground areas. Transition grind the shoulder to provide cross slope drainage.

To provide drainage and the required riding surface, transition grind auxiliary or ramp lanes from the mainline edge. The Engineer will determine the transitions from ground to unground pavement surfaces.

Seal joints after grinding and grooving.

1. **Control and Disposal of Grinding and Grooving Slurry.** Before beginning grinding and grooving, obtain the Engineer's approval of the slurry spreading and disposal method.

Do not allow grinding and grooving slurry to enter enclosed drainage systems.

If approved by the Engineer, spread slurry along the roadway slopes with the following restrictions:

- a. Spread slurry at least 5 feet away from the curb.
- b. Do not spread the slurry within 100 feet of a natural stream or lake.
- c. Do not spread slurry within 5 feet of a water-filled ditch.

If surface runoff occurs, collect and haul the grinding and grooving slurry to an Engineer-approved location on the project at no additional cost to the Department.

2. **Testing Diamond Grinding and Grooving Slurry.** The Department will take random samples of the grinding and grooving slurry and cooling water for chemical testing. Allow Department personnel access to obtain the samples.

- D. **Resealing Pavement Joints.** Saw, or re-saw, clean, and seal longitudinal and transverse concrete pavement joints in accordance with subsection 602.03.S and the following.

Saw longitudinal and transverse joints as required by the contract. Re-saw existing longitudinal and transverse joints from 1 inch to 1¼ inches deep, and of sufficient width to establish a clean face each side of the joint reservoir. Immediately after sawing, flush the joint reservoir with water to remove slurry and debris.

Provide a final cleaning just before sealing, in accordance with subsection 602.03.R. After the final cleaning, insert a backer rod into the transverse joint to provide a 1:1 width-to-depth ratio of joint sealant.

The joint faces and pavement surface must be dry before sealing joints. Seal the joint reservoir to no more than ⅛ inch (after cooling) below the surface of the pavement.

- E. **Sawing and Sealing Cracks.** Seal cracks with a hot-poured sealant as follows:

Saw cracks from ½ inch to ¾ inch deep and from ¾ inch to ½ inch wide.

After sawing, use hand tools or a lightweight chipping hammer to remove slivers of concrete, less than 1 inch wide, along the crack. Immediately before sealing, blast clean both faces of the sawed crack with dry abrasive to remove contamination and texture the faces. After dry abrasive blasting, clean the crack to remove debris using oil-free compressed air with a minimum pressure of 90 psi.

The joint faces and pavement surface must be dry before sealing joints. If the crack below the sealant reservoir is greater than ¾ inch wide, insert a backer rod into the crack to form the bottom of the reservoir at the required depth. Seal the crack to no more than ⅛ inch (after cooling) below the surface of the pavement.

If required by the crown of the roadway and the slope of the shoulder, fill the reservoir in two or more passes, place temporary dikes in the sealed reservoir, or use both methods. Remove the temporary dikes before the sealant fully cools and seal the resulting cavity. Apply the additional sealant before the previous application becomes contaminated.

603.04. Measurement and Payment

Pay Item	Pay Unit
Pavt Repr, Rem.....	Square Yard
Saw Cut, Intermediate.....	Foot
Pavt Repr, Reinf Conc, ___ inch	Square Yard

Pavt Repr, Nonreinf Conc, ___ inch	Square Yard
Non-Chloride Accelerator	Gallon
Joint, Contraction, Crg	Foot
Joint, Expansion, Erg	Foot
Joint, Expansion, Esc	Foot
Joint, Tied, Trg	Foot
Lane Tie, Epoxy Anchored	Each
Diamond Grinding Conc Pavt	Square Yard
Diamond Grooving Conc Pavt	Square Yard
Diamond Grinding and Grooving Conc Pavt	Square Yard
Resealing Trans Joints with Hot-Poured Rubber	Foot
Resealing Longit Joints with Hot-Poured Rubber	Foot
Crack Sealing, Conc Pavt	Foot
Cement	Ton

- A. **Price Adjustments for Concrete Pavement Repairs.** The Engineer will determine the final concrete pavement repair thickness in accordance with subsection 603.04.C. The Department may core the concrete pavement repairs and will adjust the unit prices for repairs that do not meet the required depth or the required reinforcement location in accordance with subsection 602.04.
- B. **Pavement Repair, Removal.** The Department considers **Pavt Repr, Rem** the removal of pavement sections without disturbing the base, as shown on the plans. The unit price for **Pavt Repr, Rem** includes the cost of the following:
1. Moving from repair to repair;
 2. Establishing grade;
 3. Saw cutting;
 4. Removing adjacent concrete shoulders, curb, curb and gutter, and valley gutter;
 5. Removing part-depth or full-depth HMA patches;
 6. Lifting the repair section without disturbing the base;
 7. Loading, hauling, and disposing of the removed material; and
 8. Placing HMA mixture, as necessary, to restore the shoulders to the existing line and grade.

The Department will include the pay item **Saw Cut, Intermediate** for sections of pavement on which the plans show **Pavt Repr, Rem**. The Department will not include the pay item **Saw Cut, Intermediate** for sections of pavement on which the plans show **Pavt, Rem**. The

Department will pay for intermediate saw cuts for concrete pavement repairs over 6 feet long, but less than 100 feet long, to allow loading onto hauling units, as **Saw Cut, Intermediate**. The Department will not pay separately for additional saw cuts to reduce slabs into pieces smaller than one lane width by 6 feet long.

The Department will pay for the removal of portions of concrete that contain partial or full-depth HMA patches as **Pavt Repr, Rem**.

- C. **Pavement Repair, Reinforced Concrete, and Pavement Repair, Non-reinforced Concrete.** The Department will establish a concrete pavement thickness for repairs, as shown on the plans, based on the original plan thickness of the existing concrete pavement plus 1 inch. The minimum thickness of the concrete pavement repair may vary by no more than 1 inch from the thickness shown on the plans.

The Department will not pay separately for work required to correct low-base conditions caused by Contractor removal operations. The Department will pay for site preparation to correct base, more than 2 inches below the required grade, not caused by Contractor operations, under the relevant pay items. If the contract does not include a relevant pay item, the Department will pay for base corrections greater than 2 inches deep, not caused by Contractor operations, as extra work.

1. **Repair.** The Engineer will measure **Pavt Repr, Reinf Conc** and **Pavt Repr, Nonreinf Conc**, of the thickness specified, longitudinally along the pavement surface, and will use the transverse dimension shown on the plans.

The unit prices for **Pavt Repr, Reinf Conc** and **Pavt Repr, Nonreinf Conc** include the cost of the following:

- a. Moving from repair to repair;
- b. Establishing grade;
- c. Providing, placing, finishing, texturing, stenciling, and curing the concrete;
- d. Providing and placing bar chairs and the steel reinforcement; and
- e. Providing additional concrete, as necessary, to correct low-base conditions that do not exceed 2 inches measured from the required grade.

- D. **Repair of Concrete Shoulders, Curbs, and Curb and Gutter.** The Engineer will measure repairs for concrete shoulders, curbs, and curb and gutter as **Pavt Repr, Nonreinf, Conc** at the same thickness as adjacent concrete pavement repairs. The Department will pay for repairing

concrete shoulders, curbs, and curb and gutter as **Pavt Repr, Nonreinf, Conc.**

E. Joints

1. **Contraction Joints (Crg).** The unit price for **Joint, Contraction, Crg** includes the following:
 - a. Making the saw cuts required at the ends of the repairs;
 - b. Removing saw slurry from the pavement surface and sawed faces;
 - c. Drilling and cleaning holes for dowel bars and deformed bars;
 - d. Providing, mixing, and installing adhesive grout;
 - e. Providing and installing dowel bars or deformed bars;
 - f. Providing and applying the dowel bar bond breaker coating;
 - g. Sawing the joint reservoirs;
 - h. Cleaning and preparing the joint reservoir; and
 - i. Providing and installing the joint reservoir sealant.
2. **Expansion Joint, Esc.** The unit price for **Joint Expansion, Esc** includes the cost of sawing the joint, providing and installing the joint filler material, and installing the joint reservoir sealant.
3. **Expansion, Erg.** The unit price for **Joint Expansion, Erg** includes the cost of the following:
 - a. Making the saw cuts required at the ends of the repairs;
 - b. Removing the saw slurry from the pavement surface and sawed faces;
 - c. Drilling and cleaning the holes for the dowel bars;
 - d. Providing, mixing, and installing the adhesive grout;
 - e. Providing and installing the dowel bars;
 - f. Providing and applying the dowel bar bond breaker coating;
 - g. Providing, drilling or punching, and installing the joint filler;
 - h. Providing and installing the dowel bar expansion caps;
 - i. Sawing the joint reservoirs;
 - j. Cleaning and preparing the joint reservoir; and
 - k. Providing and installing the joint reservoir sealant.

The Department will pay for sawing depths greater than 1 inch below the depth shown on the plans as extra work.

4. **Transverse Plane-of-Weakness Joints.** The Engineer will measure, and the Department will pay for, transverse plane-of-weakness joints in accordance with subsection 602.04.
 5. **Tied Joints (Trg).** The unit price for **Joint, Tied, Trg** includes the cost of the following:
 - a. Removing saw slurry from the pavement surface and sawed faces;
 - b. Drilling and cleaning holes for dowel bars and deformed bars;
 - c. Providing, mixing, and installing adhesive grout; and
 - d. Providing and installing dowel bars or deformed bars.
 6. **Longitudinal Joints.** The unit prices for other pay items include the cost of sawing and sealing internal and external longitudinal joints.
- F. **Lane Tie, Epoxy Anchored.** The unit price for **Lane Tie, Epoxy Anchored** includes the cost of the following:
1. Drilling and cleaning the holes;
 2. Providing, mixing, and installing the adhesive grout; and
 3. Providing and installing the deformed bars.

The unit prices for other pay items include the cost of final trim and clean-up, part-width construction, and restoring shoulders.

- G. **Diamond Grinding and Grooving Concrete Pavement.** The Engineer will include the final textured surface area in the measurement for **Diamond Grinding Conc Pavt**, **Diamond Grooving Conc Pavt**, and **Diamond Grinding and Grooving Conc Pavt**. The Department will not deduct minor areas of untextured pavement if the minor areas total no greater than 5% of the area shown on the plans.

The unit price for **Diamond Grinding Conc Pavt**, **Diamond Grooving Conc Pavt**, and **Diamond Grinding and Grooving Conc Pavt** includes the cost of cleanup, collecting, hauling, and disposing of grinding slurry. The unit prices for other pay items include the cost of additional passes or regrinding to meet ride quality requirements.

- H. **Resealing Transverse and Longitudinal Joints with Hot-Poured Rubber.** The Engineer will measure **Resealing Trans Joints with Hot-Poured Rubber** and **Resealing Longit Joints with Hot-Poured Rubber** in a straight line in the direction of each joint. The unit prices for **Resealing Trans Joints with Hot-Poured Rubber** and **Resealing**

Longit Joints with Hot-Poured Rubber include the cost of removing existing sealants, sawing, cleaning, and sealing the joints.

- I. **Crack Sealing, Concrete Pavement.** The Engineer will measure **Crack Sealing, Conc Pavt** in a straight line in the direction of each crack.